took on a comical aspect. On each side rose a swelling as if she had the mumps. With a hand-lens I found that these were blisters, white vesicles, and so buoyant as to annoy her by producing eccentric movements. I contrived to pierce them with a needle, and so to let out the confined gas. This gave immediate relief. But they came again, and by and by my surgery did not avail. They increased, and the buoyancy would raisé it to the surface, and the little sufferer despite all help would float. And so it was on the last day of February at an early hour I found poor Hippie afloat on her beam ends and dead. I had her alive just four months, and the above is but a tithe of what might be told of her pretty ways.

THE TACONIC QUESTION RESTATED.

BY T. STERRY HUNT.

§ 1. So much obscurity and misconception still exist in the minds of most geologists regarding what have been called the Taconic rocks, that it seems desirable to set forth clearly, and more concisely than has yet been done, the principal facts in the history of the two wholly distinct and very unlike groups of strata which have hitherto been included under this title, and which occupy very important places in American stratigraphy as well as in economic mineralogy. For a clear understanding of these strata, which, as originally described, lie between the crystalline schists of western New England and the continuous area of rocks belonging to the Ordovician (Chazy-Loraine) period, found along the Hudson and Champlain valleys, we must go back to the writings of Amos Eaton, in which we find, as early as 1832, a concise but complete exposition of the great stratigraphical problems presented by the region in question. The gneisses, with hornblendic and micaceous schists, of the Atlantic belt were then regarded by Eaton as the slaty or argillaceous member, constituting the lowest division, of his triple series of Primitive rocks; and were declared by him to be there followed by the second or silicious, and the third or calcareous member of the same series. These were the Granular Quartz-rock and the Granular Lime-

rock, by which names he designated the quartzite and the crystalline limestone of the Taconic (or Taghkonic) Hills in western New England.

§ 2. Above the Primitive, Eaton placed the Transition series, including, like the last, three divisions: First, at the base, a schistose or so-called argillaceous member, named by him the Transition Argillite, and representing in this second series the gneisses and crystalline schists of the Primitive. Second, a silicious member, consisting of a great group chiefly of sandstones and conglomerates, comprehensively described by him as millstone-grit, rubble, and graywacke-slate, the whole representing in the Transition series the Quartz-rock of the Primitive, and called the First Graywacke or Transition Graywacke, a term borrowed from German geologists. Third, a limestone named by him the Sparry Lime-rock, and representing in this series the Granular Lime-rock of the Primitive. Eaton insisted upon the existence of a stratigraphical break, and a discordance, between the Transition Argillite and the overlying Transition Graywacke, the distribution of which latter was described in detail. It was said to be "seen resting on the Argillite in Rensselaer County, where its subdivisions form a ridge which extends from Canada through the State of Vermont, and Washington, Rensselaer, and Columbia Counties in New York." The conglomerates of this Transition Graywacke were further said to make "the highest ridges between the Massachusetts line and the Hudson."

§ 3. To the west of Lake Champlain, along the base of the Macomb Mountains (since called the Adirondacks), and resting upon the Primitive gneiss, Eaton found what he called the Calciferous Sand-rock (a magnesian limestone, sometimes holding gypsum), which he declared to be the equivalent, in this region, of the Sparry Lime-rock, and to constitute, with its overlying Metalliferous Lime-rock (a term borrowed from Bakewell), the third or calcareous division of the Transition series. The sandstone since known as the Potsdam, which is often wanting at the base of the fossiliferous limestones in this region, was apparently unknown to him. It is here to be noted that Eaton, unlike many of his successors, did not confound these limestones, nor their stratigraphical equivalent to the east of the Hudson—the Sparry Lime-rock—with the crystalline limestone of Western Massachusetts, but recognized the fact that this, the Primitive Lime-rock, together

with the Primitive Quartz-rock and the Transition Argillite, and the great Transition Graywacke, were all alike wanting in the Adirondack region between the gneisses, constituting the lowest member of the Primitive, and the fossiliferous limestones, the highest member of the Transition series.

§ 4. Above this last he recognized a third, or Lower Secondary series, having, like the others, for its inferior member an Argillite or Graywacke-slate, and for its second or silicious member a sandstone and conglomerate. These two members were by Eaton united under the name of the Second Graywacke, which he declared to be lithologically very much like the First or Transition Graywacke, but distinguishable therefrom by the fact that it is above instead of below the Transition limestones, and is, moreover, overlaid, in its turn, by the Lower Secondary limestones. These comprised the Geodiferous Lime-rock and the Corniferous or Cherty Lime-rock, with its included layers of what he called "stratified horn-rock," in which two subdivisions we at once recognize the Niagara and Upper Helderberg limestones of James Hall. In each of these triple series Eaton recognized, in ascending order, an argillaceous or schistose, a silicious, and a calcareous member.

All of the above details of his classification may be gathered from Eaton's "Geological and Agricultural Survey of the Erie Canal" (1824), and in the second edition of his "Geological Textbook" (1832). They were set forth by the present writer, in 1878, in his volume on Azoic Rocks ("Report E of Second Geological Survey of Pennsylvania"); and more fully, with a tabular view, in an essay on "The Taconic Question," in the first and second volumes of the "Transactions of the Royal Society of Canada," in 1883 and 1884, which is reprinted, with considerable additions, in his "Mineral Physiology and Physiography" (pages 517–686) in 1886. The student who follows the painful history of the half-century of controversy which has been required to bring order out of the confusion in which his immediate successors involved this great problem of American geognosy, can only regard with reverence the wonderful insight by which Amos Eaton was enabled, at this early period, to comprehend the complex stratigraphy of the Hudson and Champlain valleys and the western slope of the Atlantic belt.

§ 5. When, a few years later, in 1837, a systematic geological

survey of the State of New York was begun, W. W. Mather was charged with the Southern district, including the region east of the Hudson, while to Ebenezer Emmons, a pupil of Eaton, was given the Northern district, to the west of Lake Champlain; Conrad, and after him Lardner Vanuxem, having the Central or intermediate district, including the counties of Oswego, Oneida, Herkimer, and Montgomery, and extending southeastward along the valley of the Mohawk to the Southern district.

Along the base of the Adirondacks, Emmons now found, in some parts, between the Transition Lime-rock of Eaton and the underlying Primitive crystalline schists, a granular or compact quartzite, which he called the Potsdam sandstone. For the rest, he did no more than confirm the determinations of his master, retaining the Birdseye or Encrinal Lime-rock of the latter as a subdivision of the Metalliferous Lime-rock, to the upper and lower portions of which he gave the names of Trenton and Chazy; while in the succeeding Second Graywacke he recognized as subdivisions, the Utica slate, the Loraine shale, the Gray or Oneida, and the Red or Medina sandstone, all of which, with the inclusion of the Potsdam sandstone, he called the Champlain division of the New York system. The last two members of this were, however, subsequently joined to what was called the Ontario division of the same system.

§ 6. The metamorphic hypothesis was then in fashion with some American geologists, and had already been applied by Nuttall, as early as 1822, to the rocks of Southeastern New York, the gneisses and crystalline limestones of which he supposed to have been formed by a subsequent alteration of portions of the adjacent graywacke and fossiliferous limestones. Mather, in extension of this notion, conjectured that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite of Eaton might, in like manner, be the results of an alteration of the members of the Champlain division of Emmons, excluding the upper sandstones; and in his final Report in 1843, on the Geology of the Southern district of New York, further maintained that not only the divisions of Eaton just mentioned, but the crystalline rocks in that State lying to the south and east of the Highland range, comprising Westchester and New York Counties, and embracing Manhattan Island, like the similar rocks of western New England, were "nothing more than the rocks of the Champlain di-

vision, modified greatly by metamorphic agencies and by the intrusion of granitic and trappean aggregates." The passage between the unaltered and the altered rocks was supposed to offer a gradual transition, and it was asserted that "no well-marked line of distinction can be drawn, as they blend into each other by insensible degrees of difference," or what have since been called successive "grades of metamorphism." These same notions were soon afterwards adopted by Logan for the crystalline rocks of the Atlantic belt in Canada, and for a time were extended by H. D. and W. B. Rogers to the gneisses and crystalline schists of the White Mountains.

§ 7. A similar view was also adopted for Pennsylvania by H. D. Rogers, then engaged in a geological survey of that State, who maintained with Mather that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite of Eaton, which are prolonged into Pennsylvania, were but the altered representatives of the Potsdam sandstone with the succeeding limestones and the Utica slate and Loraine shale of the Adirondack region. These silicious, calcareous, and argillaceous groups were named by him respectively the Primal, Auroral, and Matinal divisions of the palæozoic series, and were also called Nos. I., II., and III. in his notation. These he supposed to appear in a more or less metamorphosed and crystalline condition in the southeastern part of Pennsylvania; while farther westward in the State they occur in their unchanged fossiliferous condition, as in the Adirondack region, and are there conformably overlaid by the Oneida and Medina sandstones, which constitute together the Levant division, or No. IV. in the nomenclature of H. D. Rogers.

§ 8. The First Graywacke of Eaton, which in Eastern New York overlies the Transition Argillite, regarded by Mather as the altered representative of the Utica slate, was supposed by him to be the succeeding Loraine, Oneida, and Medina subdivisions. He thus denied the distinctness of the great belt which Eaton had traced from Canada, through Vermont, along the line between Massachusetts and New York, and confounded it with the lithologically similar Second Graywacke.

The areas of this First Graywacke, which in the southeastern part of Pennsylvania occur above the so-called "altered Auroral and Matinal," but below the horizon of the typical Levant or Oneida sandstone, were supposed by H. D. Rogers to be a part

of the Matinal, and were thus virtually made a part of the Second Graywacke. It is not too much to say that this denial by Mather of the existence of the First or Transition Graywacke, and the confounding of the great belt of this (which stretches from the lower St. Lawrence to the Susquehanna, and beyond) with the Second Graywacke, was a great and fatal error in the stratigraphy of the whole region, from the consequences of which American geology has not yet escaped. It was, however, a legitimate consequence of the hypothesis of regional metamorphism applied by Mather to the great underlying series consisting, in descending order, of the Transition Argillite, the Primitive Limerock, and the Primitive Quartz-rock of Eaton, and of his attempt to identify these with the members of the Champlain division.

§ 9. Rocks belonging to the Second Graywacke are indeed found upon the banks of the Hudson River, and Mather had already, in his fourth annual report, given the name of Hudson slates to what he rightly regarded as the equivalent of those named Loraine shale by Emmons, and Pulaski shales by Vanuxem, in their respective districts. The latter, however, noticed in the Central district of New York besides these shales (which, in its northwest portion, are directly overlaid by the Gray or Oneida sandstone) an underlying series of greenish argillites and sandstones, including some graptolitic shales, but destitute of the fauna of the upper division. The lower, named by him the Frankfort division, appear in the southeast part of the district without the overlying Pulaski or Loraine division, the two being, according to Vanuxem, "not co-extensive with each other," and so distinct that he insisted on treating them separately, inclining to the opinion that they ought not to be put together in local geology. He further declared that they are separate in Pennsylvania, the characteristic Pulaski shales appearing in the Nippenose valley west of the Susquehanna, while the Frankfort slates and sandstones are seen to the east of the North Mountain in the Kittatinny or Appalachian valley, and include the roofing-slates of the Delaware. These rocks in the latter region are, in fact, the Transition Argillite and the First Graywacke, which latter is there seen, in some localities, resting upon the roofing-slates, though in many others, in the absence of this First Graywacke, the same Argillite is directly overlaid by the Levant sandstone of the Second Graywacke.

Vanuxem, having in view the contradiction between the opinions of Eaton and Emmons on the one hand and those of Mather on the other, suggested that to the lower or Frankfort division might belong the thick masses of strata "of controverted age" along the Hudson valley. Notwithstanding the evidence put forward by him as to the distinctness of these two divisions, Vanuxem, apparently for the purpose of avoiding controversy, included both the Frankfort and the Pulaski divisions under the collective name of the "Hudson River group." That these two divisions were, moreover, supposed by him to be associated with a still older series lithologically resembling them appears from his language when he wrote of "the difficulty of separating or distinguishing the slaty and schistose members of the Hudson River group from those of greater age with which, along their eastern border, the two [divisions] are more or less, really or apparently, blended." In fact, as appears from the observations of Vanuxem in Pennsylvania, and as will be further shown elsewhere, the Hudson River group of Vanuxem included alike the Transition Argillite, the First Graywacke, and portions of the Second Graywacke. The subsequent palæontological studies of James Hall in New York for many years, however, had chiefly to do with the uppermost division of this heterogeneous assemblage, and hence the name of Hudson River group has come to be very generally regarded as synonymous with Loraine shales.

§ 10. Meanwhile, Emmons came forward as the champion of the views of Eaton, and while his field of official labor did not extend to the regions occupied by the rocks now in question, declared in his final Report on the Geology of the Northern District of New York, that some account of them was necessary to a correct understanding of the relations of the Champlain division. A curious contradiction is, however, apparent in the volume in question, in certain parts of which the views of Mather are set forth, while in others Emmons remains faithful to the teachings of his master, which he ever afterwards followed. As regards the great belt called by Eaton the First Graywacke, we find, in the account of the Champlain division, described as belonging to the Pulaski or Loraine horizon, the belt of red and purple slates with red sandstones extending "through the higher parts of Columbia, Rensselaer, and Washington Counties" in New York, "and onward through Vermont into Canada." Again, we are

told that portions of this same belt belong to the Loraine subdivision and the succeeding Gray sandstone, and that these last rocks are represented by the sandstones of Burlington and Colchester, Vermont, and also by those used in the fortifications of the city of Quebec. This whole Graywacke belt, as traced out by Eaton, is thus here referred, in accordance with the view of Mather, to the horizon of the Second Graywacke.

In another place in this same volume we find a discussion of the relations of the Transition or Sparry Lime-rock of Eaton to the Primitive Lime-rock, which in some sections apparently overlies it to the eastward, in which it is suggested that the latter may be younger rather than older than the Sparry Lime-rock.[1] This argument has lately been cited by J. D. Dana against the views maintained by Emmons in other chapters of the same volume, in which are set forth the teachings of Eaton that the Primitive Quartz-rock, the Primitive Lime-rock, and the Transition Argillite are, contrary to the hypothesis of Mather, inferior not only to the Trenton limestone, but to the whole New York palæozoic system, and are, moreover, directly overlaid by the Graywacke series in question, which is in turn succeeded by the Sparry Lime-rock. The whole of these, from the base of the Primitive Quartz-rock, are described in detail by Emmons in his volume of 1842, in chapters vii., viii., and ix., as belonging to a distinct system, for which the name of the Taconic system was then proposed. This Report of Emmons can thus be quoted against himself, as has been done by his opponents, for the passages already cited, which are introduced in other parts of the same volume, set forth the wholly opposed views of Mather as to the rocks in question. The secret history of these curious contradictions in this officially published Report on the Geology of the Northern District of New York, and of the persistent war waged alike against Ebenezer Emmons and his views and those of Amos Eaton, has yet to be written.

§ 11. These perplexing discrepancies and contradictions in the volume of 1842 were mentioned by the present writer in 1878 ("Azoic Rocks," p. 57) as probably due to want of method and to a change of views in the preparation of the work. In 1885 the dis-

[1] See for the preceding references the "Geology of the Northern or Second District of New York," by E. Emmons, 1842, pp. 121, 124, 125, 280–282, and further, p. 147.

cordances were again noticed,[1] when it was said of the volume, that Emmons therein "showed a divided opinion as to the horizon of the First Graywacke." This might be supposed to indicate the acceptance, for a time, of the views of Mather before finally adopting those of his old master, Eaton. It will, however, be noted that the passages, four or five pages in all, found intercalated in different parts of his account of the New York System, inculcating the doctrines of Mather,[2] are in complete opposition alike to the whole teaching in the three chapters—vii., viii., and ix. (pp. 135–164)—given to the Taconic System, and to his extended monograph thereon, published in 1844, so that one is led as an explanation of this strange contradiction to suppose that the passages in question may be interpolations by another hand. There is a painful resemblance in many respects between the story of Emmons and his opponents[3] and that of the warfare waged against Sedgwick by Murchison and his allies in the famous Cambrian and Silurian controversy, as set forth by the present writer in 1874 in his "Chemical and Geological Essays" (pp. 364, 365).

§ 12. The Taconic system, in the chapters just mentioned of this report of 1842, was said to include, in ascending order, the "Granular quartz" (or Primitive Quartz-rock), the "Stockbridge limestone" (or Primitive Lime-rock), and the "Magnesian slate." This latter, the Transition Argillite, comprehended, besides the characteristic roofing-slate, a great mass of soft and more or less schistose rocks, which, from the prevalence in them of hydrous micas (and occasionally of chlorites), have an unctuous character,

[1] Mineral Physiology and Physiography, pp. 522, 583, 584, 587.

[2] Loc. cit., pp. 121, 124, 125, 147, 279, 282.

[3] In a letter from Emmons to Marcou, dated Raleigh, N. C., December 29, 1860, he writes, "I made and published with my Report a modified map of the State, which showed the extent of the Taconic rocks in New York. The three thousand copies were stolen or destroyed by persons unknown, so that they were never issued with the proper volume. The rocks illustrating the Taconic system in the State Cabinet were all taken out, by order. . . . My existence as one of the State geologists was ignored at the last meeting of the American Association for the Advancement of Science in Albany [1851]. In fine, the persecution I suffered for opinion has rarely been equalled. . . . The editor of the *American Journal of Science* refused to publish my remarks upon Logan's report when he [Logan] announced his Huronian system, though their tenor was courteous in the extreme. I claimed that the Huronian was only the Taconic system." (Marcou on the Taconic System, 1885, Proc. Amer. Acad. Science, xii. 188.)

supposed to indicate the presence of magnesian silicates. Besides the three above named, there were, according to Emmons, two other divisions, the "Sparry limestone," by which he designated the Sparry Lime-rock of Eaton, and the "Taconic slate." This latter, which he declared to be quite distinct from the Magnesian slate, had, according to Emmons, been traced one hundred and fifty or two hundred miles, and included another band of roofing-slates. It is said to be more or less interstratified with limestones, and "often becomes a coarse graywacke." This Taconic slate, thus defined by Emmons in 1842 as the uppermost member of his "Taconic system," is, as will be seen, the First or Transition Graywacke series of Eaton.

Emmons, moreover, at this time calls attention to the fact that the Primitive Lime-rock, or Stockbridge limestone, "being often sparry, and of fine texture, is mistaken for the true Sparry limestone." He further remarks that as the succession of these disturbed strata is "unsettled, or at least not so clearly established as desirable," he follows their geographical order in describing them, but proceeds to tell us that the "Taconic slate" group lies between the so-called Hudson River or Loraine rocks on the west and the Sparry limestone on the east, and, moreover, that "it is undoubtedly overlapped by the former rocks, and passes beneath the latter with a dip of 30°–35°." The whole Taconic system was further described by him at this time as "the rocks lying between the upper members of the Champlain group and the Hoosic Mountains," and was, moreover, regarded "as inferior to the Potsdam sandstone, or as having been deposited at an earlier date than the lowest member of the New York Transition system."[1] The precise relations of this Transition system to the Silurian and Cambrian systems of the British geologists, and indeed the limits of these in England, were not at that date clearly understood; but Emmons, in 1842, supposed that the Taconic rocks in part might "be equivalent to the Lower Cambrian of Sedgwick," "*the upper portion being the lower part of the Silurian system*," to which the Middle and Upper Cambrian were then, on the authority of Murchison, very generally referred. That he accepted the extreme views of Barrande, and the pretensions of Murchison as to the downward extension of the limits of the Silurian, is shown by the language of Emmons, quoted farther on.

[1] Loc. cit., pp. 140, 144, 163.

§ 13. Meanwhile, Emmons continued his studies, and in 1844 published his monograph on the Taconic system, which was in 1846 republished in his "Agriculture of New York," where it forms Chapter V. (pp. 45–112). Therein, while giving a more detailed account of the Taconic system, he made one important and significant change. In 1842, while maintaining that the upper portion of this is "the lower part of the Silurian system," he had nevertheless supposed that the whole succession was deposited before the time of the lithologically dissimilar Champlain division, which, although the base of the New York system, was not by him regarded as the base of the Silurian. In this he was at variance with the teachings of Eaton, who already, as early as 1832, had declared the Transition or Sparry Lime-rock—which he placed at the summit of the Transition Graywacke or Taconic slate group—to be the stratigraphical equivalent of the Calciferous Sand-rock of the New York Transition system. Emmons had, previous to 1846, concluded that the formation of limestones of this sparry type "occurred at intervals during the whole period of the deposition of the Taconic slate," and, acquiescing in the judgment of Eaton, now declared that the upper portion of the Taconic system,—namely, the great belt of slates with limestones, sandstones, and conglomerates,—designated by him in 1842 as the Taconic slate, and including both the Transition Graywacke and the Sparry Lime-rock of Eaton, was the stratigraphical equivalent of the lower part of the Champlain division, and in fact a thickened and modified form of the Calciferous Sand-rock, which was now said to be, in its eastern extension, "protean" in its character, and to include a great variety of rocks.

§ 14. For the better identification of this Taconic slate group it is important to note that Emmons, who had already, in 1842, clearly defined its eastern and western limits in New York, and declared that it had been traced north and south a distance of one hundred and fifty or two hundred miles, repeats with detail, in 1844, the facts of its distribution. It is described as occupying geographically the interval between the overlying Loraine shales,—the upper part of the Champlain division,—on the west, and "the great mass of the Sparry limestone," which forms its eastern border, and itself lies at the western base of the Taconic Hills; which are made up of the three lower members of the Taconic system. He now adds that "the Taconic slate, with its subor-

dinate beds, occupies almost the whole of Columbia, Rensselaer, and Washington Counties, and is of immense thickness." He describes it "from Lansingburgh to the Sparry limestone on the east" as having a breadth of at least twenty miles, and, while signalizing repetitions in the section, still supposes that its volume "exceeds that of all the members of the New York system put together," adding that, "without doubt, this immense rock admits of subdivision." He declares that in the breadth of fifteen or twenty miles across this belt "the observer will pass several times over the same beds, which are brought to the surface by successive uplifts."

The nature of the uplifts by which these subdivisions of the Taconic slate group are thus repeated is further shown by an ideal section, afterwards published in his "American Geology," ii. 48. The real order of succession, as then defined, was, at the base, greenish, chloritic-looking sandstones, followed, upwards, by a great variety of different colored slates, sandstones, and conglomerates, including, moreover, what is designated as sparry limestone, black shaly limestone, and, at the summit, fine black slates.

(To be continued.)

HISTORY OF GARDEN VEGETABLES.

BY E. LEWIS STURTEVANT, A.M., M.D.[1]

(Continued from page 59.)

ARACACHA. *Aracacha esculenta* De C.

THIS South American plant is yet included among garden vegetables by Vilmorin. It was introduced to notice in Europe in 1829 and again in 1846, but trials in England, France, and Switzerland were unsuccessful[2] in obtaining eatable roots.[3] It was grown near New York in 1825,[4] and at Baltimore in 1828 or 1829,[5] but was found to be worthless. Lately introduced to India, it is now fairly established there, and Mr. Morris[6] considers it a most valuable plant-food, becoming more palatable and de-

[1] Director of the New York Agricultural Experiment Station, Geneva.
[2] Heuze, Les Pl. Alim., ii. 509.
[3] Decaisne & Naudin, Man., iv. 137.
[4] N. Eng. Farmer, July 22, 1825.
[5] Farmers' Library, 1847, 94.
[6] Gard. Chron., July 10, 1886, 50.